

Ambient Concentrations of Manganese Compounds in EPA Region 5

Q: What are the trends in outdoor air quality and their effects on human health and the environment?

The above question pertains to all 'Outdoor Air' Indicators, however, the information on these pages (overview, graphics, references and metadata) relates specifically to "Ambient Concentrations of Manganese Compounds in EPA Region 5". Use the right side drop list to view the other related indicators on this question.

Introduction

Manganese is a naturally occurring metal that is ubiquitous in the environment. Exposure to low levels of manganese in the diet is considered to be nutritionally essential for people and animals (ATSDR, 2008). However, exposures to elevated concentrations of manganese are harmful to human health and have been associated with subtle neurological effects, such as slowed eye-hand coordination. Manganese compounds are hazardous air pollutants emitted by iron and steel production plants, power plants, coke ovens, and many smaller metal processing facilities. Manganese also may be contributed in border communities by vehicles using Canadian fuel with the additive methylcyclopentadienyl manganese tricarbonyl (MMT), though use of MMT in Canadian gasoline has decreased dramatically in recent years (ATSDR, 2008).

Although manganese compounds are air pollutants of concern nationwide, they are of special concern in EPA Region 5. The 2002 National Emissions Inventory (NEI) showed that Region 5 had the highest manganese emissions of all EPA Regions, contributing 47.7 percent of all manganese compounds emitted nationwide (U.S. EPA, 2010a). Emissions from industrial sources in Region 5 occurred from various facilities, such as those that manufacture steel or process iron ores and alloys for steelmaking. Between 1988 and 2009, manganese emissions from point sources as reported to the Toxics Release Inventory declined both nationally and in EPA Region 5. During this 22-year period, national manganese emissions decreased 22.5 percent, or 1 percent per year, and Region 5 emissions declined 69.4 percent, or 3.3 percent per year (U.S. EPA, 2010b).

EPA's National Air Toxics Assessment (NATA) is intended to provide a better understanding of the health risks resulting from inhalation exposure to air toxics. The most recent NATA results (U.S. EPA, 2010c) identify manganese compounds as the largest contributor to neurological non-cancer health risk in the U.S. Modeled estimates of ambient manganese compounds in all 3,222 U.S. counties show that among the 50 counties with the highest concentrations nationwide, 17 are located in EPA Region 5.

This indicator presents ambient concentrations of manganese compounds measured as total suspended particulates (TSP) by direct monitoring. This indicator addresses manganese in the TSP fraction (not PM₁₀ or PM_{2.5}) because it is the most complete dataset in EPA Region 5 in terms of geographic and temporal coverage. TSP metals data have been commonly used in human health risk assessments. EPA recommends PM₁₀ as the most appropriate fraction for evaluating people's exposure to toxic metals (U.S. EPA, 2002), but PM₁₀ metals data are sparse at this time, both nationally and in EPA Region 5. Data from a limited number of sites in EPA's Air Quality System (AQS) with collocated PM₁₀ and TSP speciation monitors suggest that the proportion of manganese in PM₁₀ versus TSP is about 50 percent at most sites and can be as high as 75 percent. TSP

manganese data therefore should be considered a conservative estimate of PM₁₀ manganese exposures. PM_{2.5} metals data are plentiful since the establishment of the Speciation Trends Network in 2000, but this size fraction is believed to underestimate human exposures.

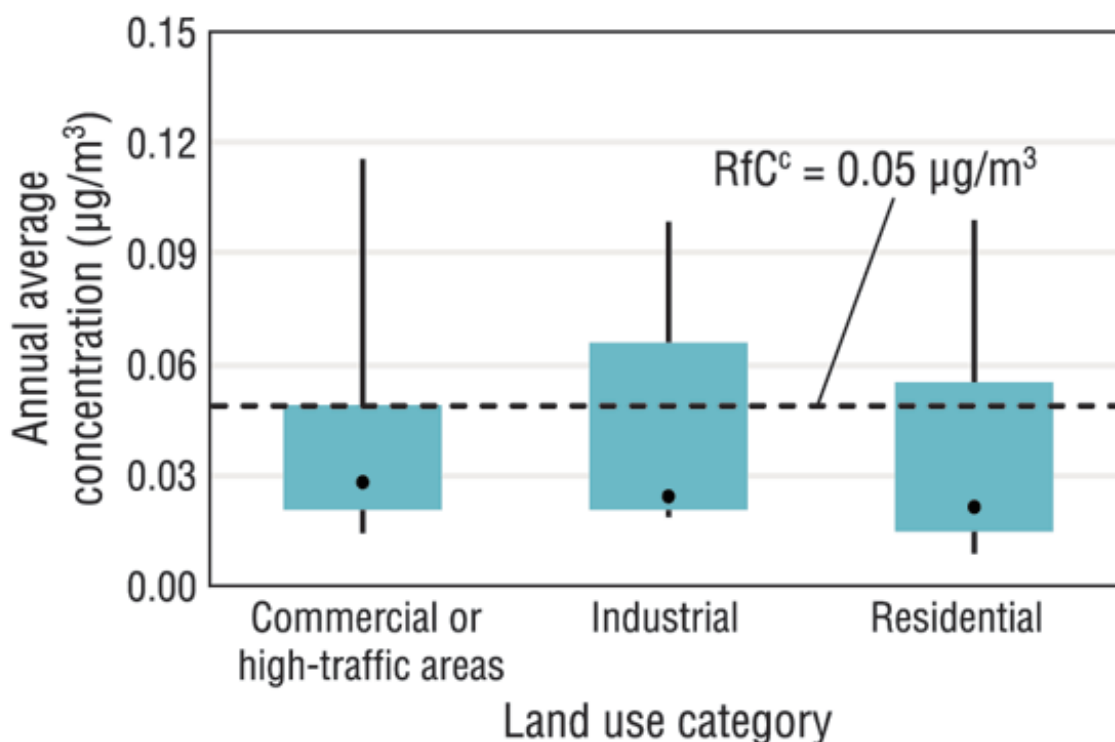
Data were considered for 53 urban and suburban monitoring sites in EPA Region 5 that had a complete year of data reported to the AQS national database in 2009. Average manganese concentrations were calculated for each monitoring site. A concentration trend was determined using the 21 monitoring sites with nine or more complete years of data between 2000 and 2009. As annual average concentrations are representative of long-term inhalation exposures, the ambient monitoring data are displayed in comparison with the manganese reference concentration (RfC). The RfC is an estimate of a chronic inhalation exposure that is likely to be without appreciable risk of adverse non-cancer effects during a lifetime. The RfC for manganese is 0.05 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), based on impairment of neurobehavioral function in people. At exposures increasingly greater than the RfC, the potential for harmful effects increases (ATSDR, 2008; U.S. EPA, 1999). Monitoring sites were classified into different categories based on land use as defined in AQS.

What The Data Show

In 2009, the median average annual ambient concentrations of manganese as TSP in EPA Region 5 were 0.021 $\mu\text{g}/\text{m}^3$ at the 16 residential sites, 0.028 $\mu\text{g}/\text{m}^3$ at the 15 sites in commercial or high-traffic areas, and 0.024 $\mu\text{g}/\text{m}^3$ at the 22 industrial sites (Exhibit 2-48). Greater concentration differences were observed in the 90th percentile values: 0.115 $\mu\text{g}/\text{m}^3$ at the commercial and high-traffic sites; 0.098 $\mu\text{g}/\text{m}^3$ at the residential sites; and 0.098 $\mu\text{g}/\text{m}^3$ at the predominantly industrial sites. In 2009, 17 of the 53 urban and suburban monitoring sites had average manganese concentrations higher than the RfC; seven of these sites were categorized as industrial, five commercial or high-traffic, and five residential.

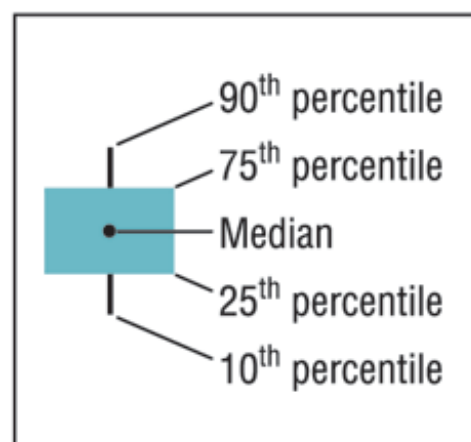
The average annual manganese concentration averaged across 21 trend sites showed a 49 percent decline between 2000 and 2009 (Exhibit 2-49). The trend sites had the following land use designations: commercial and high-traffic (six sites), industrial (nine sites), and residential (six sites). None of the trend sites had agricultural or forest land use designations.

Exhibit 2-48. Ambient manganese concentrations in EPA Region 5 by land use category, 2009^{a,b}



^a**Coverage:** 53 monitoring sites in EPA Region 5, with 15 sites in commercial or high-traffic land use areas, 22 sites in industrial areas, and 16 sites in residential areas.

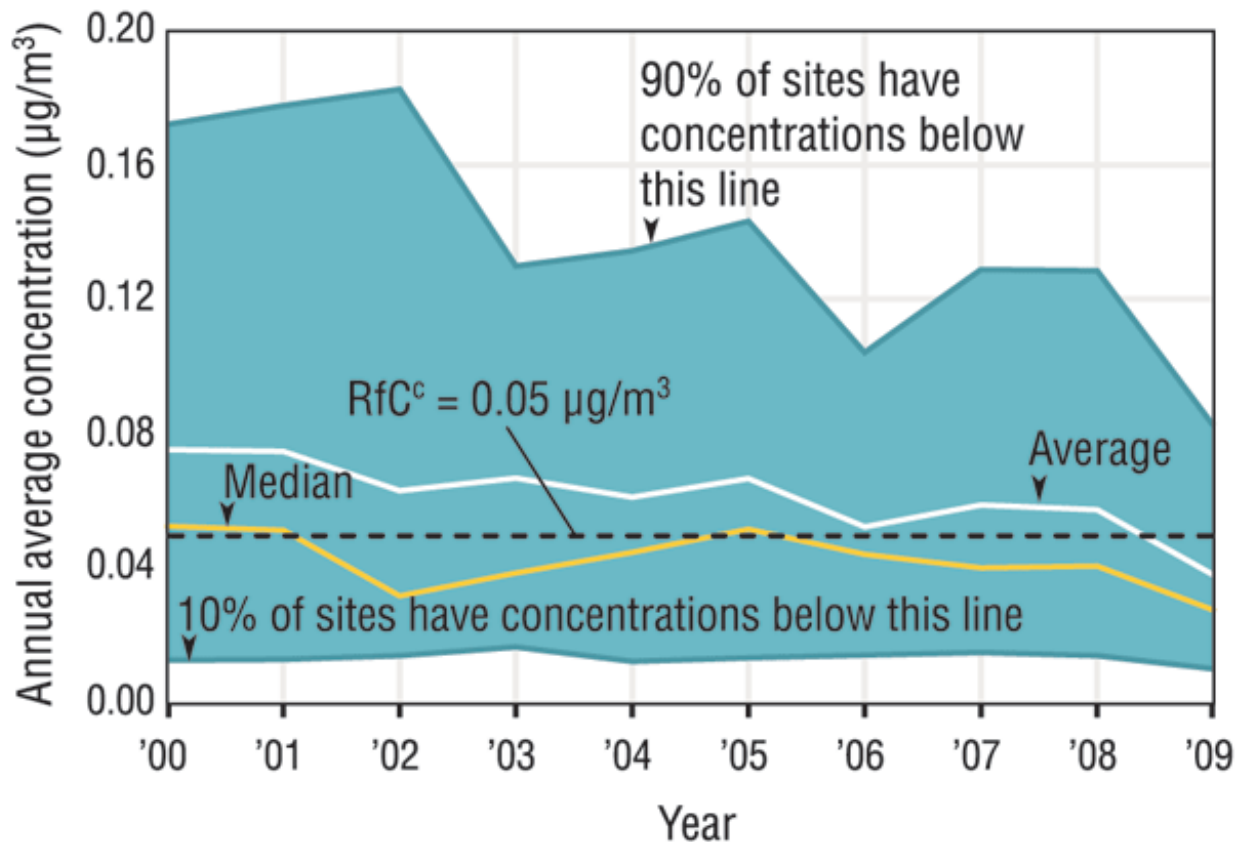
^bConcentrations are for manganese in total suspended particulate matter.



^cThe reference concentration (RfC) is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Data source: U.S. EPA, 2010d

Exhibit 2-49. Ambient manganese concentrations in EPA Region 5, 2000-2009^{a,b}



^a**Coverage:** 21 monitoring sites in EPA Region 5 (out of a total of 53 urban and suburban monitoring sites measuring manganese in 2009) that have sufficient data to assess manganese trends since 2000.

^bConcentrations are for manganese in total suspended particulate matter.

^cThe reference concentration (RfC) is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Data source: U.S. EPA, 2010d

Limitations

- AQS data represent several sites per state, but do not have full geographic or temporal coverage. Some emissions “hotspots” are included, while others may exist that have not been monitored.
- The land use categories are only generally indicative of the area represented by an ambient air monitor. For example, a site categorized as “industrial” may adjoin a densely populated community where many residents are exposed to ambient pollution.

Data Sources

Summary data in this indicator were provided by EPA Region 5, based on ambient air monitoring data for manganese compounds reported in EPA’s AQS (U.S. EPA, 2010d) (<http://www.epa.gov/ttn/airs/airsaqs/>). Trends in this indicator are based on the subset of monitoring stations located in EPA Region 5 that have sufficient manganese concentration data to assess trends over the period of record.

References

ASTDR (Agency for Toxic Substances and Disease Registry). 2008. Toxicological profile for manganese (update). Draft for public comment. Atlanta, GA: U.S. Department of Health and Human Services <http://www.atsdr.cdc.gov/toxprofiles/tp151.pdf>.

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